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# Studying the impact of galaxy cluster morphologies on their detection through SZ effect

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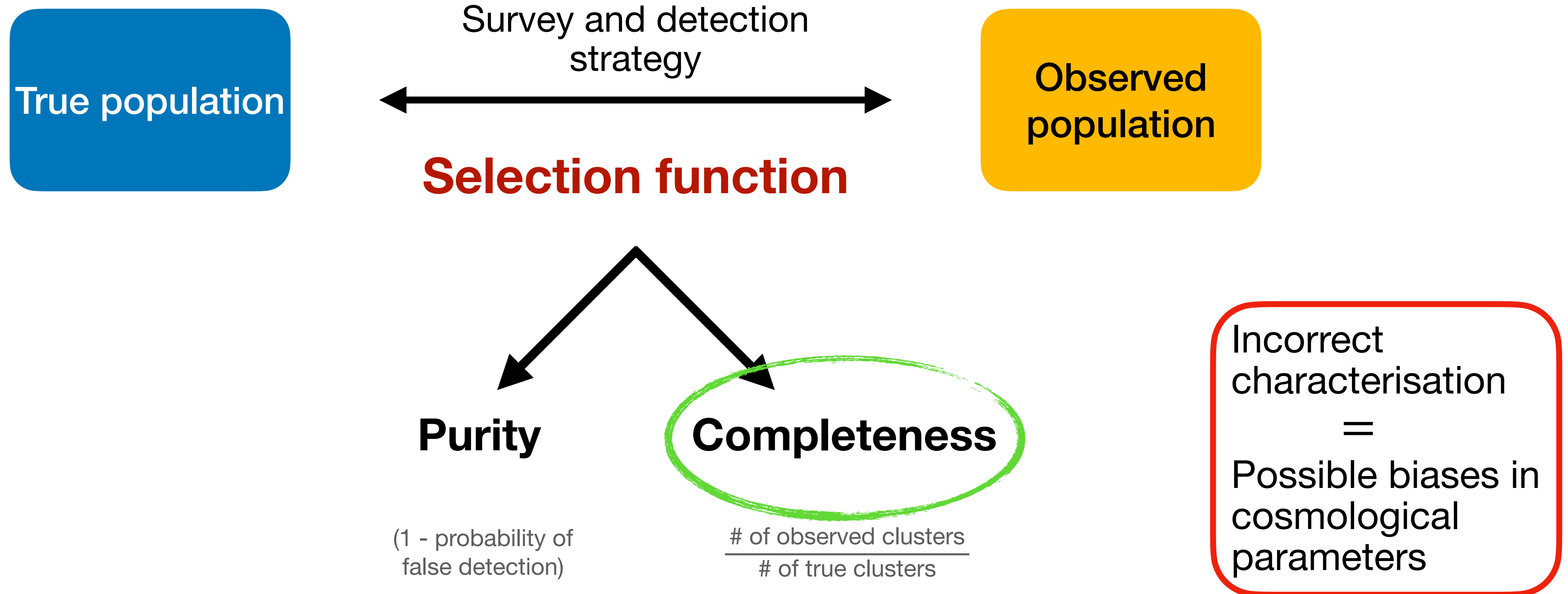
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# Context - Selection Function

**Galaxy clusters** → dependence on cosmological parameters:  $\Omega_m, \sigma_8$

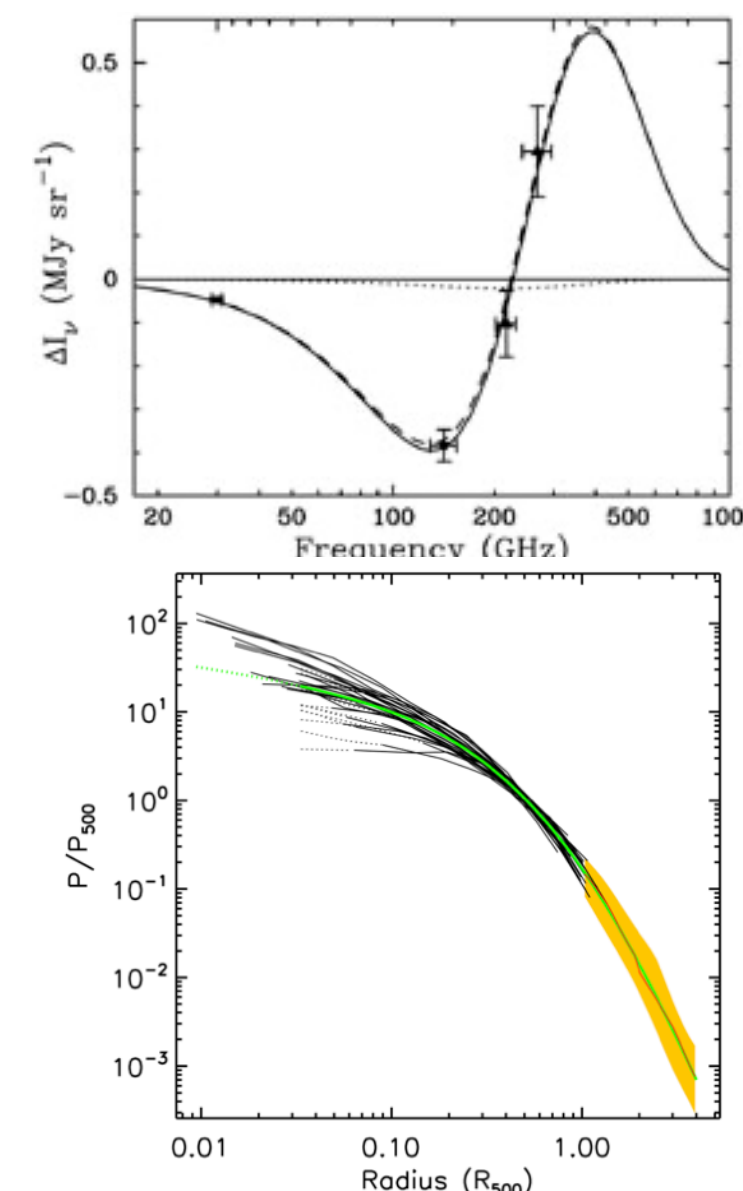
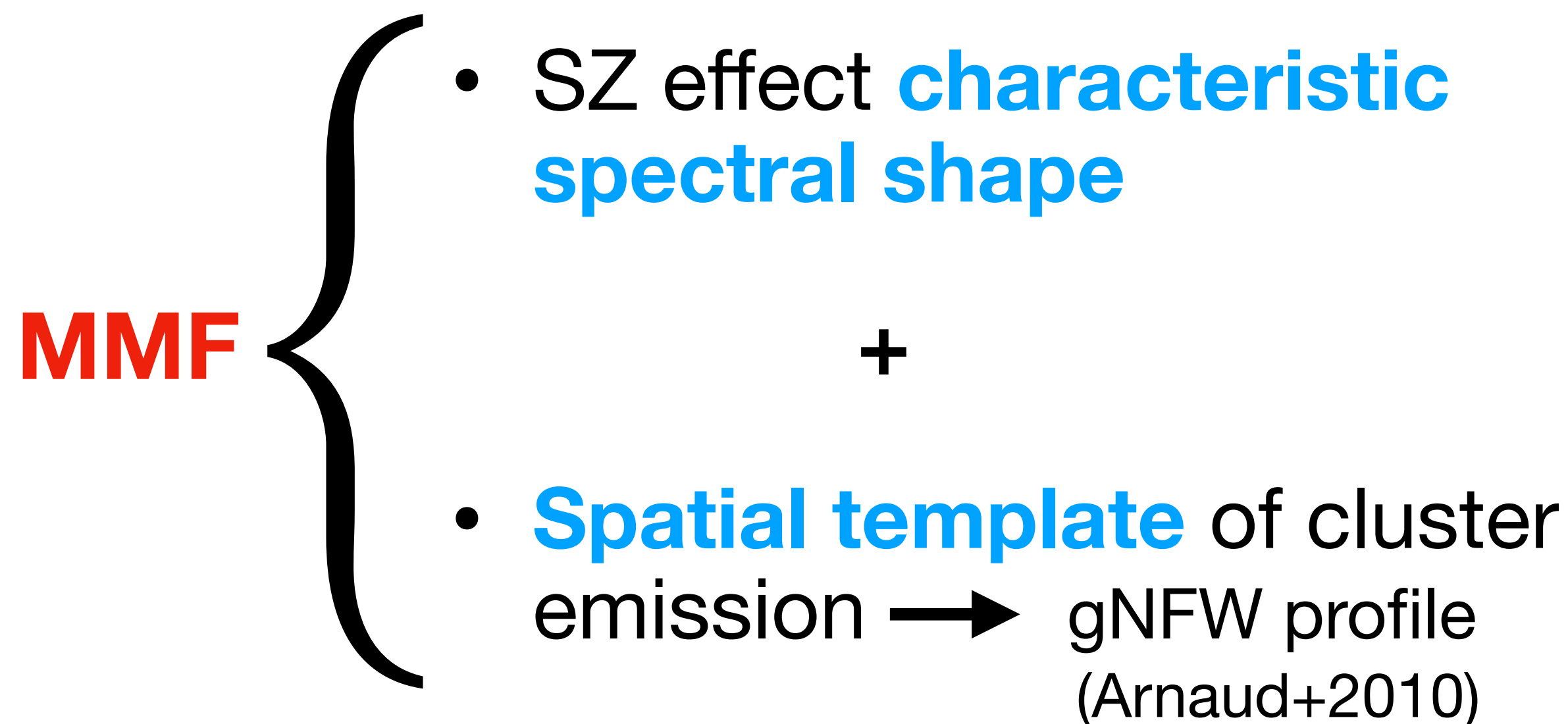
One of the main ingredients in cosmological analyses:



# Cluster Detection via SZ Effect

- Sunyaev Zel'dovich effect** → spectral distortion of CMB due to inverse Compton scattering off hot electrons
- signal proportional to integrated pressure along l.o.s., tight relation with cluster mass
- independent on cluster redshift

A common detection method: **Matched Multi-Filter** (Melin+2006)



Outputs →

Catalog of detections:

- Position
- $\theta_{500}$
- $Y_{5R500}$
- SNR

- If one assumes **Gaussian errors** on the Compton-y signal, the completeness can be estimated as:

$$P(d | Y_{5R500}, \sigma(\theta_{500}), q) = \frac{1}{2} \left[ 1 + \operatorname{erf} \left( \frac{Y_{5R500} - q \sigma(\theta_{500})}{\sqrt{2} \sigma(\theta_{500})} \right) \right]$$

PlanckXX(2013),  
PlanckXXIV(2015)

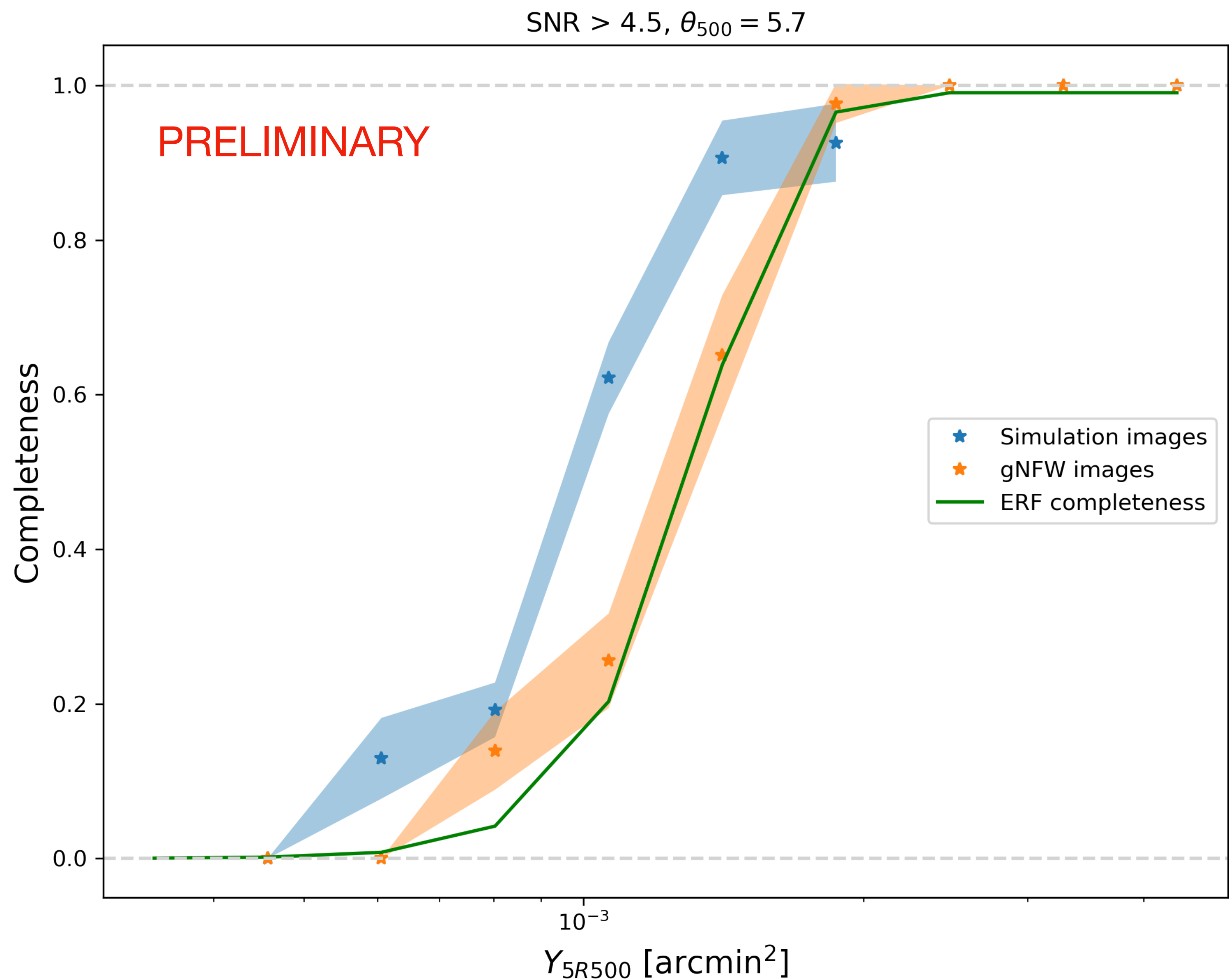
- **Another approach: inject** simulated cluster signals in the Planck frequency maps, and check how many are **recovered** by the detection algorithm

## Generated images

- Projected gNFW profile (Arnaud+2010)
- As in PlanckXXIX (2013), PlanckXXVII (2015)

## Simulation images

- IllustrisTNG-300 hydrodynamical simulation
- $M_{500} > 1.5 \times 10^{14} M_{\odot}$ ,  $0.06 < z < 0.2$
- 6 projections per cluster



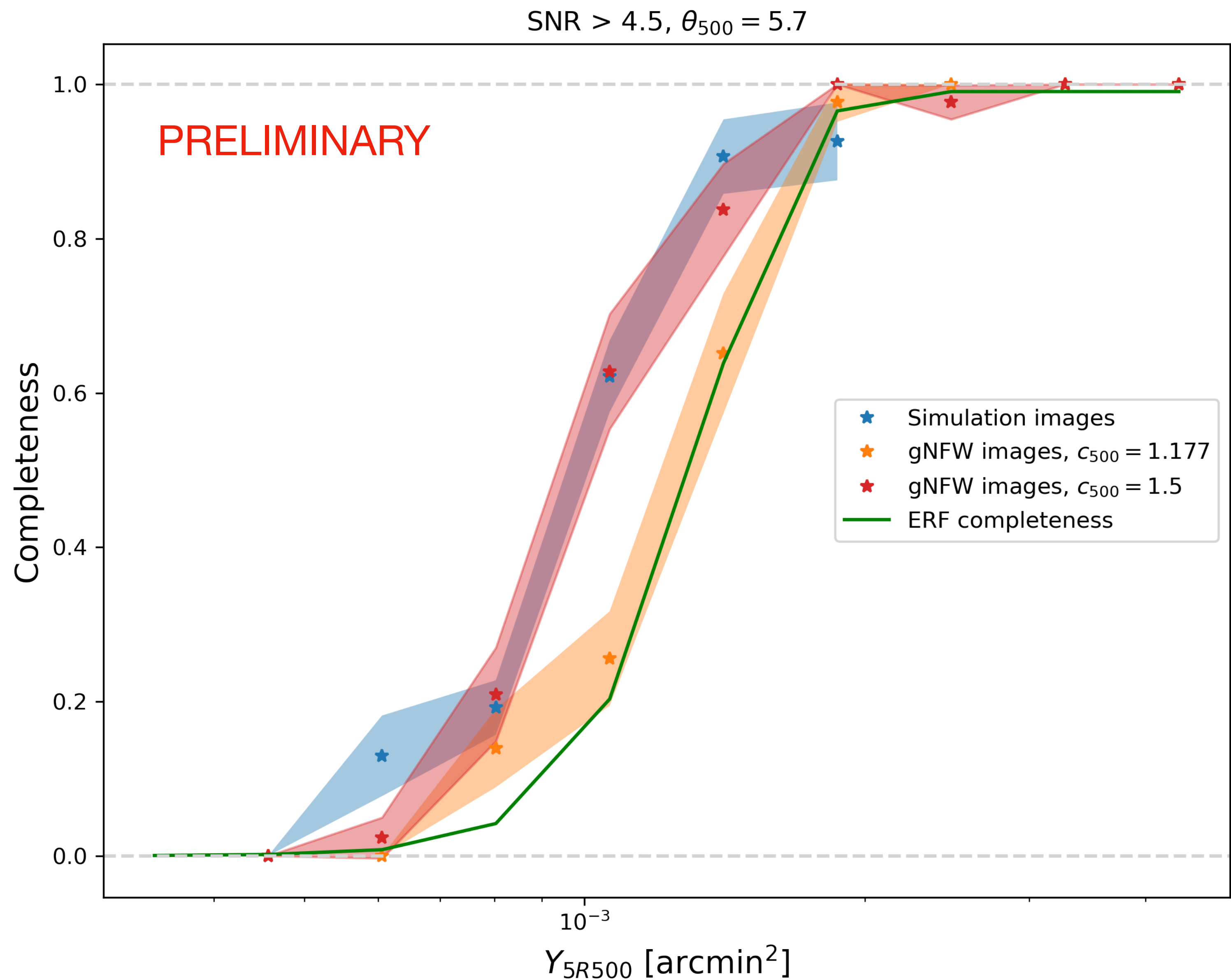
Completeness of **gNFW** profile images ~ **analytical ERF estimation**

**BUT**

**Simulation images** show higher completeness than spherical **gNFW** ones



# Results - a possible explanation



If we use a set of images with **higher central peak** (= gNFW with higher concentration), we get a completeness similar to the one of the **simulation images**

- These first results suggest that the completeness can possibly depend on **different cluster parameters** beyond those of the simple ERF estimate
- For example the clusters' **peak signal** seems to have an impact on the completeness
- **Limitations:** few patches analysis, few radii, limited statistics

## Next steps

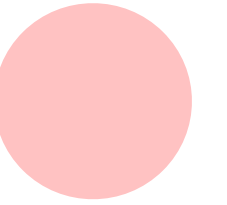
- Move to full sky analysis (different noise levels and mask effects)
- Use different hydrodynamical simulations
- Explore the impact on cosmological parameters' constraints

Thank you



**Backup**

# Cosmology with clusters



$$\frac{dN}{dz} = \int d\Omega \int dM_{500} \hat{\chi}(z, M_{500}, l, b) \left( \frac{dN}{dz dM_{500} d\Omega} \right)$$

**Mass function**

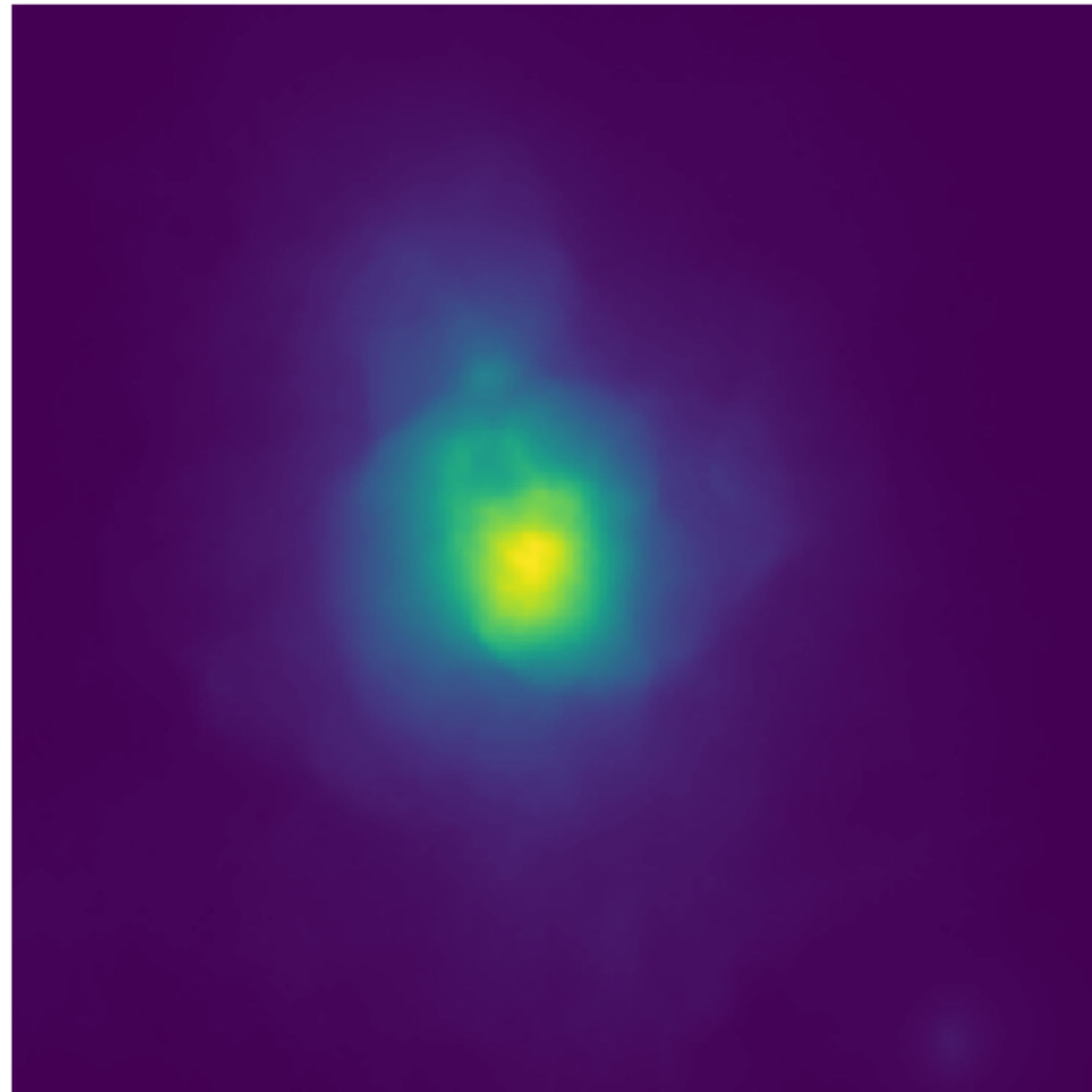
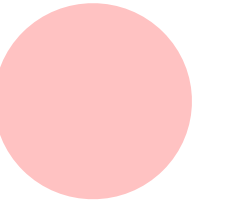
$$\hat{\chi} = \int dY_{500} \int d\theta_{500} P(z, M_{500} | Y_{500}, \theta_{500}) \chi(Y_{500}, \theta_{500}, l, b)$$

**Scaling relations**

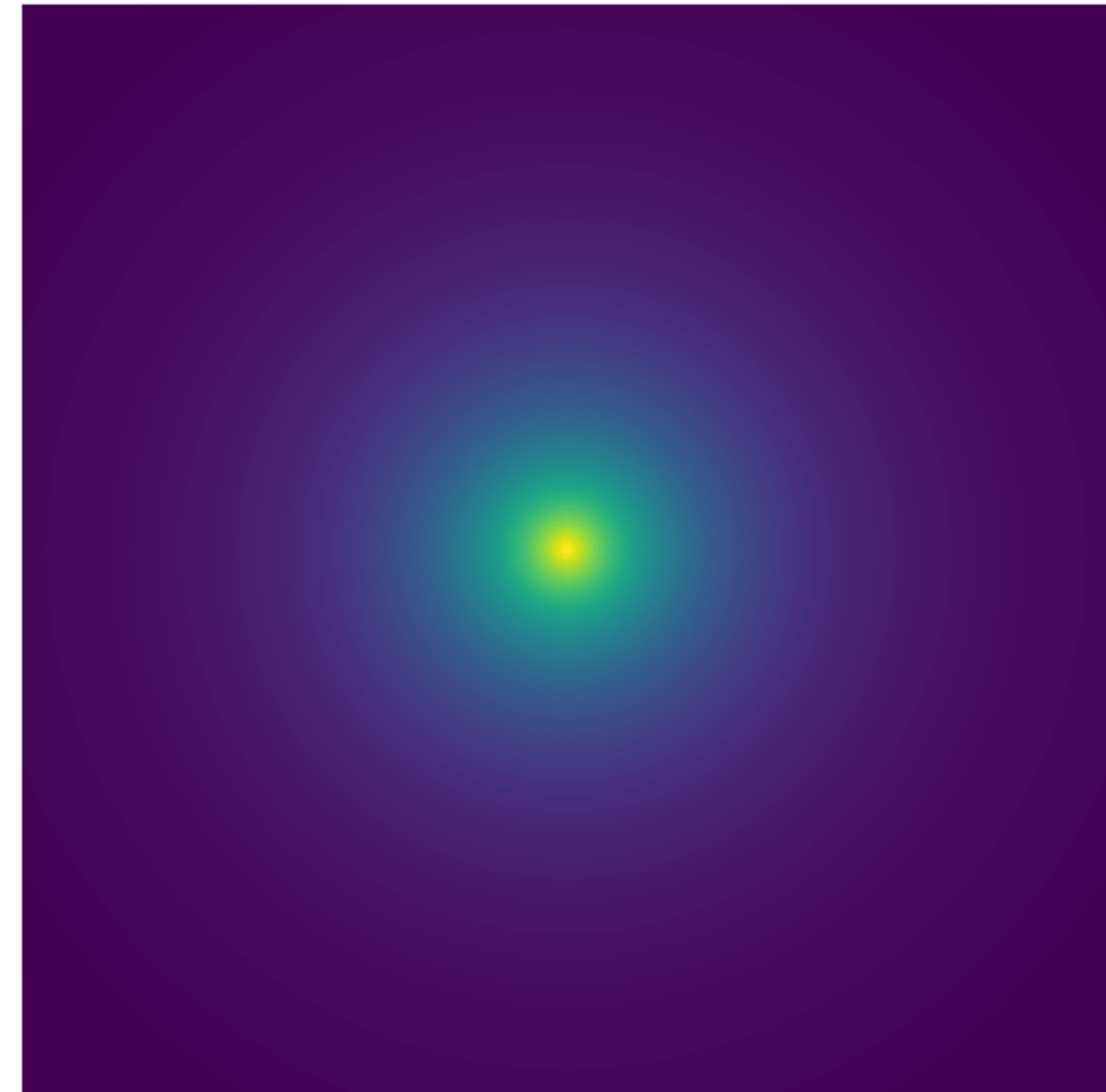
**Selection function**

# Cluster images

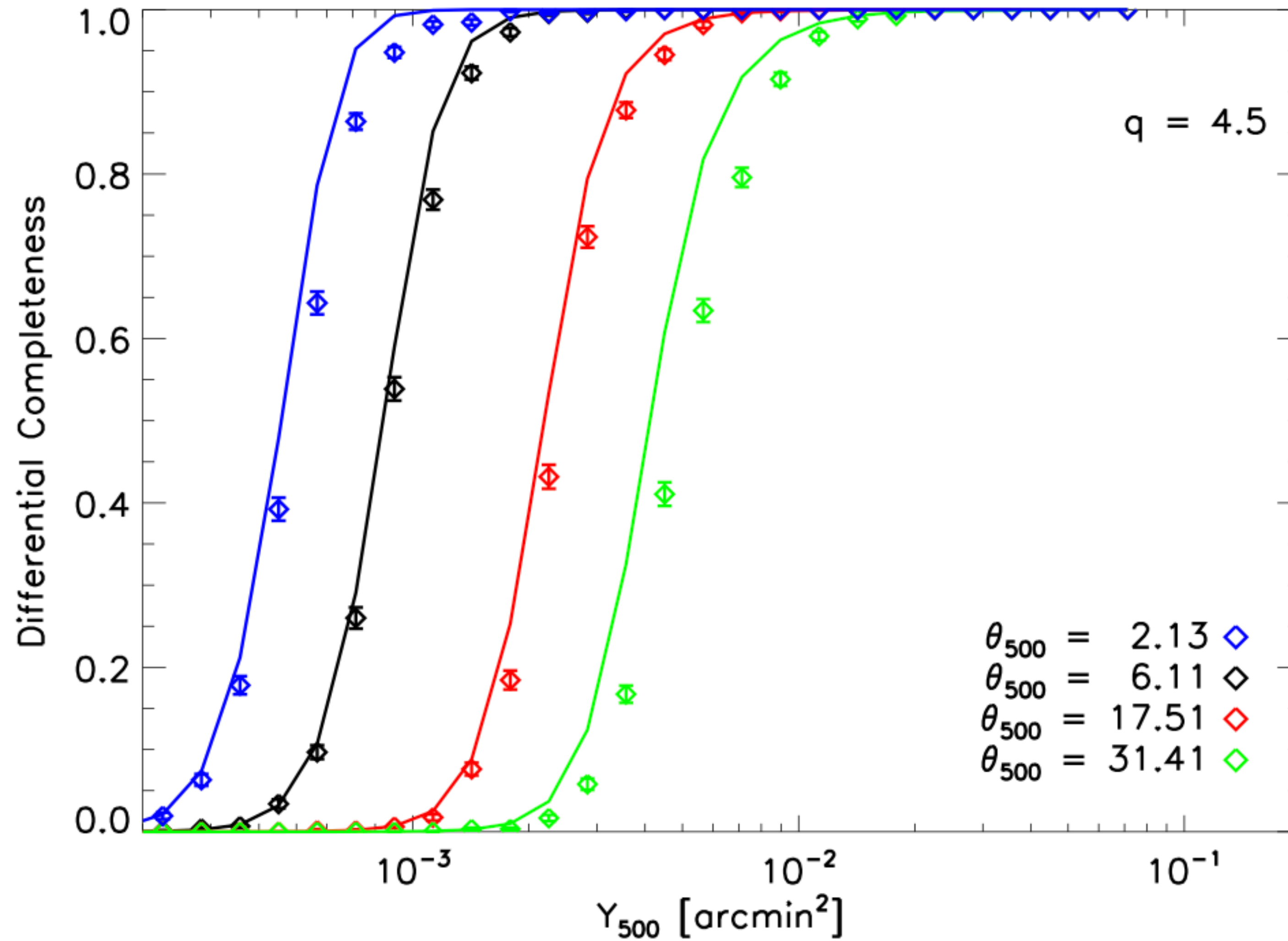
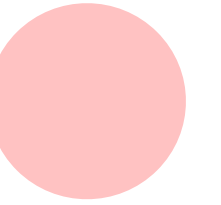
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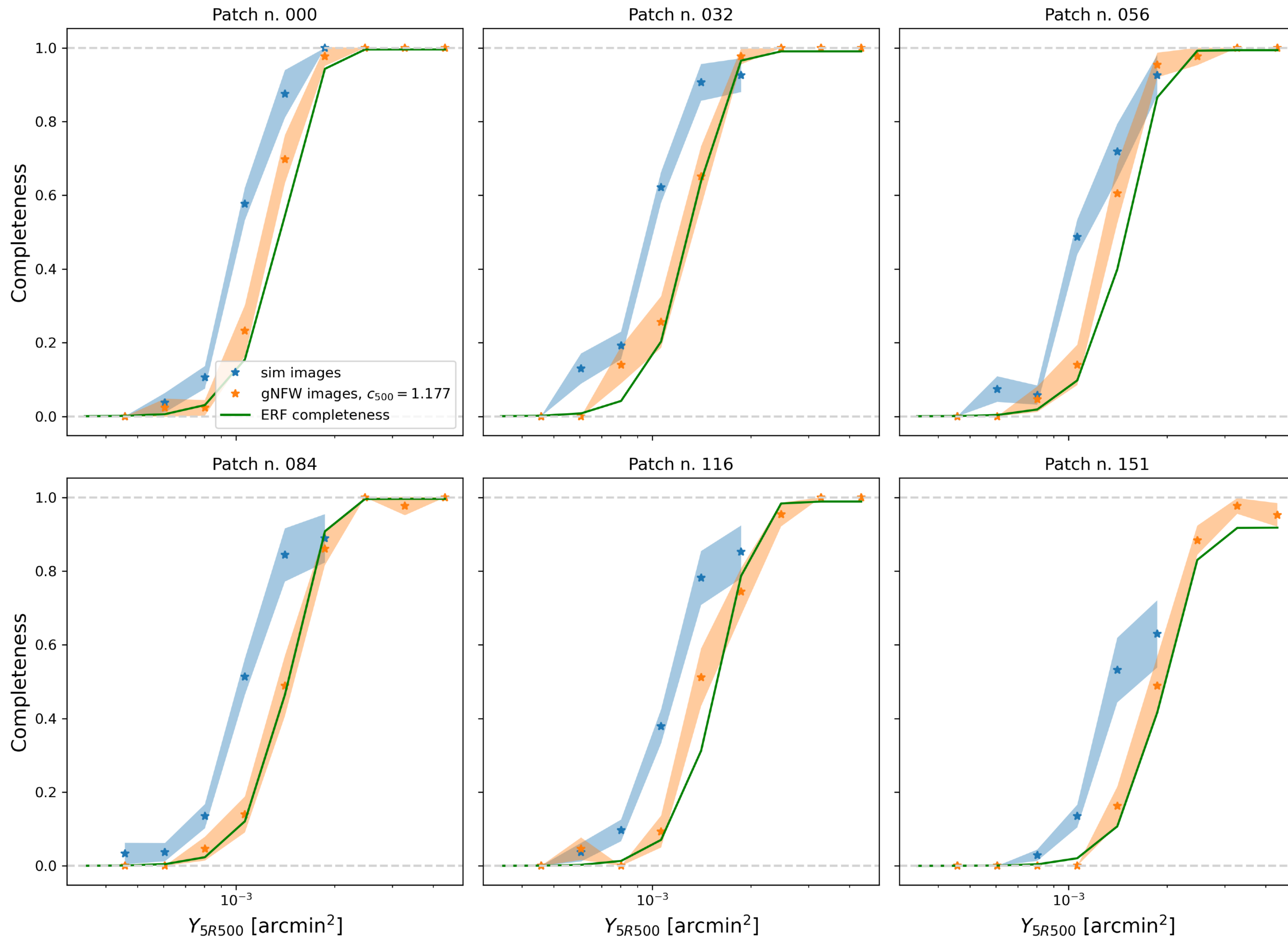
Simulation

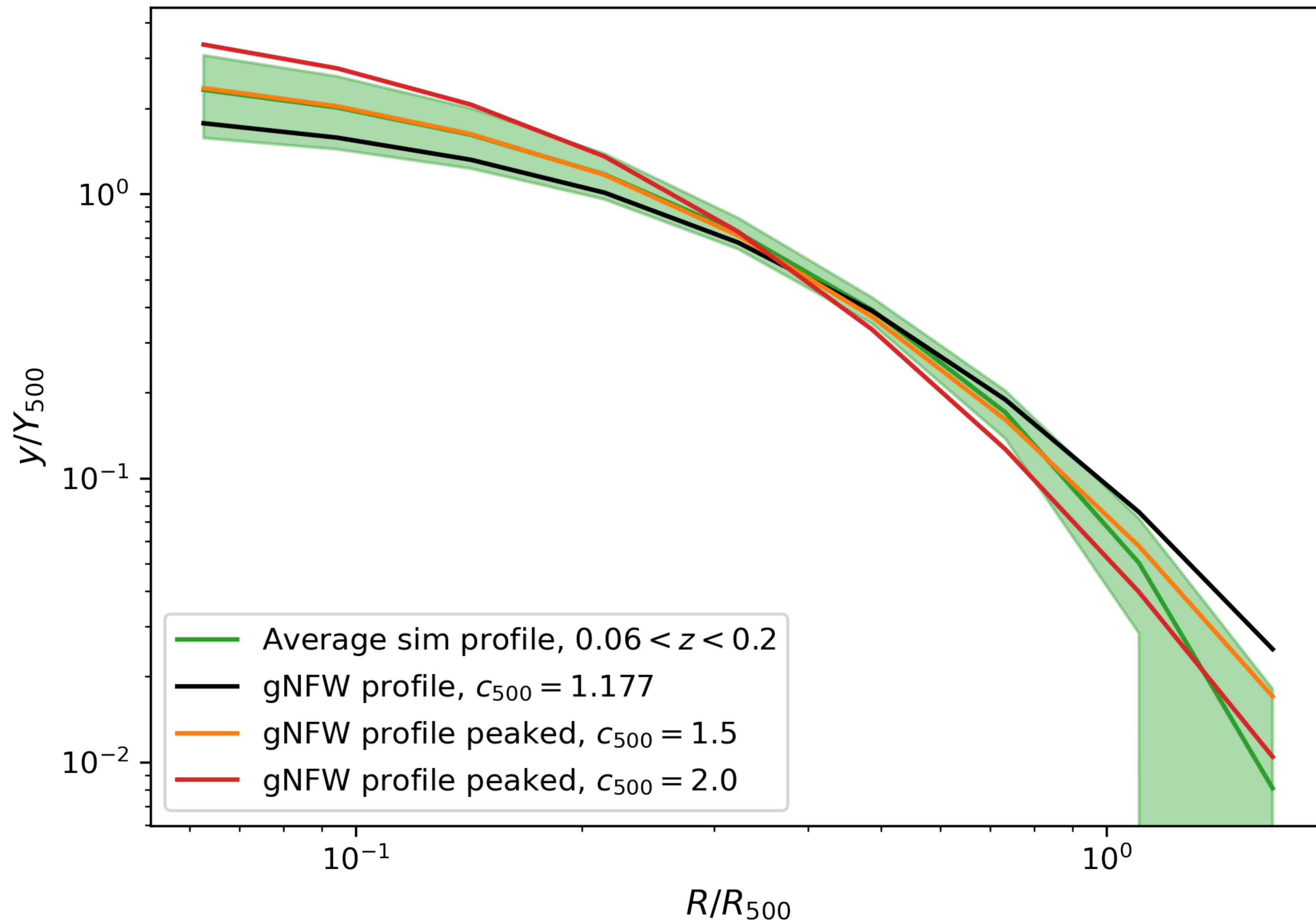


gNFW



SNR > 4.5,  $\theta_{500} = 5.7$  arcmin







SNR > 4.5,  $\theta_{500} = 5.7$

